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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G02B 27/01, H04N 5/57	A1	(11) International Publication Number: WO 98/10322 (43) International Publication Date: 12 March 1998 (12.03.98)

(21) International Application Number: PCT/HU96/00051

(22) International Filing Date: 5 September 1996 (05.09.96)

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(81) Designated States: BR, CA, CN, JP, KR, RU, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

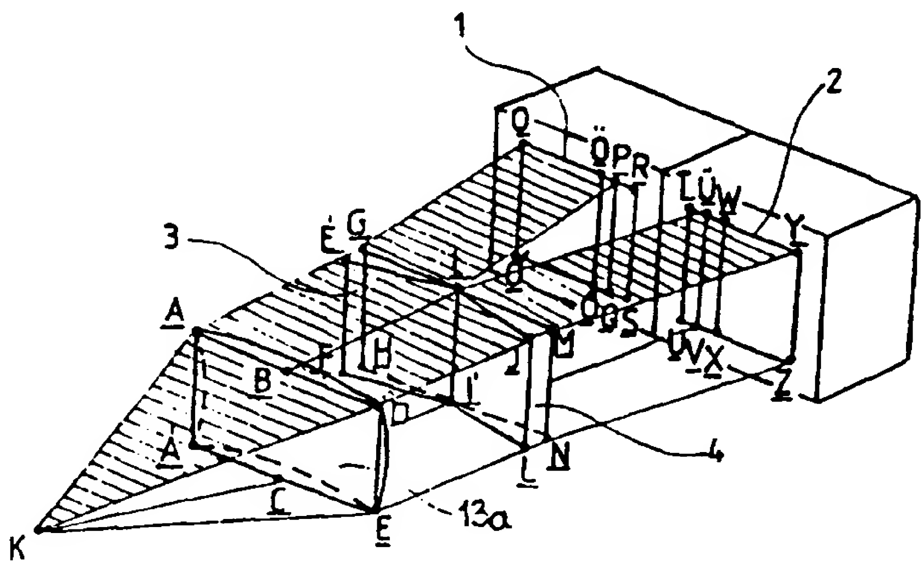
Published

With international search report.
With amended claims.

(54) Title: HEAD WORN STEREOSCOPIC DISPLAY DEVICE, PARTICULARLY FOR DISPLAYING TELEVISION PICTURES

(57) Abstract

A head worn stereoscopic display device, particularly for displaying television pictures, having more than one screen (1, 2) facing each eye, which screens display the full picture in mosaic-like parts with overlapping edges (ÖÓ'RS, TUWX). Primary optical elements (3, 4) directing the light paths side by side are arranged in the light paths from the screens (1, 2) to the centre (K) of the eye; the edges (II) or said optical elements (3, 4) cannot be seen, and thereby the part pictures of the screens (1, 2) make up a single compound picture without any boundaries.



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HEAD WORN STEREOSCOPIC DISPLAY DEVICE, PARTICULARLY FOR DISPLAYING TELEVISION PICTURES

The invention relates to a head worn stereoscopic display device, particularly for displaying television pictures, having more than one screen facing each eye, which screens display the full picture in mosaic-like parts with overlapping edges. Optical elements directing the light paths side by side are arranged in the light paths from the screens to the pupil of the eye; the edges of said optical elements cannot be seen, and thereby the part pictures of the screens make up a single compound picture without any boundaries.

The first attempt to present a more realistic picture of the natural or artificial environment was a table stereoscope (David Brewster) displayed at the London World Exhibition in 1851; the viewer looking into this device saw two pictures of the same object made at different angles. The majority of the modern video helmets and glasses display television pictures on the same principle. Head worn devices are described in the Japanese Patent No. 2-128007, German Patent No. 1103961, Hungarian Patent No. 874743, and in the US Patents No. 5123726, 4897715, 5371556, 5276471 and 4706117; these devices have a television screen for both the left and the right eye, said screens are placed in a rigid cover and

can be seen through lenses and eventually mirrors. If the optical elements are adjusted exactly, the pictures seen by the left eye and the right eye, respectively, appear virtually in front of the head of the viewer in a distance of some metres, and merge into a single picture.

The common large screen television sets (for use in rooms) having a screen diagonal of 50-80 cm are usually viewed from a distance of 2-4 m, i.e. at a visual angle of maximum 10°, which is substantially smaller than the visual angle of 25-50° of wide screen cinemas. In the case of head worn miniature screens (smaller than 1") viewed through lenses, the visual angle of the television picture can be insreased by increasing the optical magnification theoretically at will. However, this is limited by the resolution of the television picture, because the lines of the picture are getting more and more visible, which is rather disturbing. It is known from experience that the picture on an LCD screen consisting of e.g. 180000 picture elements (pixels) disintegrates, i.e. breaks up into points, when the visual angle is larger than a relatively small value; therefore, the increase in magnification cannot be continued. Nevertheless, the visual angle should be increased, because the experience of reality is directly proportional to the visual angle.

It is therefore the object of this invention to provide a television picture display device, where - using screens of a

given resolution - the dimensions of the picture can be further increased without deteriorating the resolution, i.e. the picture quality. This can be achieved by placing more than one screen - instead of one - in front of both the left and the right eye, and
assembling the pictures of said screens continually for the eyes by optically hiding the separating frame zones of the screens.

The invention is based on the recognition that television pictures can be assembled without any boundaries, if the screens display the full television picture in mosaic-like parts with overlapping edges (repeating the same picture zones); and primary optical elements directing the light paths side by side are arranged in one or every one of the light paths starting from the bigger part of the screens beyond one of the so-called picture equivalent lines, expediently the middle one called joining line, and arriving in the central point of the corresponding eyeball; and the edges of said optical elements, hindering the view of the picture, are made invisible.

The object of this invention can be accomplished by three sorts of optical elements, namely wedge prism, plane mirror and lens, if said optical elements have an optically effective edge running parallel to the joining line of the overlapping picture zone of the corresponding screen (in a given light path), said optically effective edge is sharp or it seems as a line for the eye looking at, because it is a narrow edge surface, the

plane of which passing through the central point of the eyeball; said primary optical elements and screens are arranged in the space relative to each other and the central point of the eyeball in such a manner that the light paths starting from the bigger part of the screens beyond the joining line and arriving in the central point of the eyeball define polyhedrons having sections between said primary optical element(s) and the centre of the eyeball touching each other along a plane or planes containing the optically effective edge(s) and the centre of the eyeball.

Actually, the light paths passing through the pupils reach as far as the eyeground, and not only as the centres of the eyeballs. As the diameter of the pupils changes depending on the light intensity, and, on the other hand, the situation changes too, as the eyeball turns in the eyehole, but the centre of the eyeball remains stationary; therefore, it is convenient to regard this point as the end of the light paths.

In the most general embodiment of the device according to the invention, more than one screen are placed in front of both the left and the right eye, the picture columns of said screens (vertical edges of the pictures) being parallel to each other; and primary optical elements directing the light paths side by side are arranged in one or every one of the light paths starting from the bigger part of the screens beyond the joining line, and arriving in the central point of the eyeball. A focusing

element, preferably a magnifying lens or lens system, extending over the full cross section of the light paths is placed between the eyeball and the primary optical element(s).

In a preferred embodiment, further magnifying lenses are placed in the light paths to increase the magnification. To achieve a more compact device, the light paths can be broken by mirrors. The frame carrying the screens and the optical elements can be fixed to the head by means of bands or a helmet provided with earphones or loudspeakers.

The present invention will now be described by way of examples with reference to the accompanying drawings, in which:

Fig. 1: rays of light starting from two screens, passing through two wedge prisms and arriving in a point-like pupil P, where the distance between the screens and the wedge prisms is s_1,

Fig. 2: rays of light starting from two screens, passing through two wedge prisms and arriving in a point-like pupil P, where the distance between the screens and the wedge prisms is s_2,

Fig. 3: rays of light starting from two screens, passing through two wedge prisms and arriving in a point-like pupil P, where the distance between the screen and the wedge prism is s_3,

Fig. 4: rays of light starting from two screens, passing through two wedge prisms and arriving in a dot-like pupil,

Fig. 5: the picture on screen 1, and a diagram showing the change of the light intensity of the picture,

Fig. 6: the picture on screen 2, and a diagram showing the change of the light intensity of the picture,

Fig. 7: the picture united by the wedge prisms, and a diagram showing the change of the light intensity of the united picture,

Fig. 8: combination of the pictures of two screens by two wedge prisms,

Fig. 9: combination of the pictures of two screens by one wedge prism,

Fig. 10: combination of the pictures of four screens by four wedge prisms,

Fig. 11: combination of the pictures of two screens by one mirror,

Fig. 12: combination of the pictures of two screens by two mirrors,

Fig. 13: combination of the pictures of two screens by two lenses,

Fig. 14: combination of the pictures of four screens by four lenses,

Fig. 15: a schematic top-view of a preferred embodiment of the device according to the invention, without the means fixing the device to the head,

Fig. 16: a schematic side elevational view of another preferred embodiment of the device according to the invention, without the means fixing the device to the head,

Fig. 17: a schematic front elevational view of the device according to Fig. 16,

without the means fixing the device to the head, and

Fig. 18: a perspective view of the device according to Fig. 16, fixed to the head.

As shown in Fig.1, two screens 1 and 2 are placed side by side at a distance t measured between their frames; said screens are arranged in front of a pupil P (considered as a point) at a distance d; between the screens and the pupil P, two wedge prisms 3 and 4 are placed at a distance s_1 from said screens; rays of light from the screens 1 and 2 travel to the pupil P not along a straight line but they are refracted by the optically effective surfaces of the prisms. According to Fig. 2, there is a distance s_2 at which the rays of light starting from the adjacent edges of the screens 1 and 2 coincide with each other after the wedge prisms. According to Fig. 3, if the distance s_3 between the sreens and the wedge prisms 3 and 4 is greater than s_2, the rays of light from adjacent edges of screens 1 and 2 do not reach the pupil P.

At a given distance d between the screens 1, 2 and the pupil P, the distance s_2 depends on the distance t between the screens, and - at a given refractive index n - on the prism angle α of the wedge prisms 3 and 4. If the distance t is increased, the distance s_2 and/or the prism angle α must be increased, too. The relation between a distance s_2 meeting given conditions and the variables d, t, n and α can

be determined by mathematical functions as well.

As shown in Fig. 4, in the case of a real, spot-like pupil P, the adjacent edge zones of the screens 1 and 2 can be overlapped for the viewer. Going from the point I on the right side screen 2 to the left, the point L is the last one from which a ray of light can reach any point of the pupil P through the extreme point C of the right side wedge prism 4, as indicated by the rays of light l_N and l_M. Going further to the left beyond the point L, a ray of light from the point J can reach only the half of the pupil on the right side of point V, and a ray of light from the point I can arrive only at point M of the pupil P. Therefore the light intensity seen by the viewer decreases gradually to zero from the point L of the screen towards the point I. Similarly, the point E on the left side can be seen with full luminousity, but when advancing towards the point G, the light intensity falls linearly to zero. Since the E-G section of the left side screen 1 and the I-L section of the right side screen 2 overlap each other, the light intensities add and complement each other at any point. Naturally, if the overlapping parts of the screens represent the same thing, the two images coincide and appear as a single image. If the screens 1 and 2 represent the left and the right side of the same picture, respectively, overlapped on the sections EG and IL, as shown in Fig. 5 and 6, a single, continuous image will be seen according to Fig.

7, i.e. the images on screens 1 and 2 merge into one another imperceptibly, and the light intensity f is equalised.

In Fig. 8, the screens 1 and 2 are arranged in such a manner that their picture columns (vertical edges of the pictures) are parallel to each other, the boundaries ÖŐ and WX of the overlapping parts of the pictures are parallel to the vertical edges RS and TU of the pictures, the widths of the overlapping zones ŐÖRS and TUWX of the pictures are equal and amount to 10-50 % of the total widths of the screens. The overlapping zones OÖRS and TUWX represent the same on the screens 1 and 2, so the corresponding picture columns, called picture equivalent lines, represent the same as well. The rays of light starting from the picture equivalent lines coincide after passing point C, as indicated with broken and dotted lines in Fig. 4. The middle of the picture equivalent lines, i.e. the bisecting line of the overlapping zone of each picture, called joining line, is indicated as line PQ and ÜV, respectively, in Fig. 8.

The wedge prisms 3 and 4 join along the line IÍ which is parallel to the joining lines PQ and ÜV. An important condition of merging the screens 1 and 2 togethet without any boundaries is that the line IÍ should not be visible for the eye. This is possible if said line is sufficiently near the pupil, advantageously nearer than 5 cm; in this case, the eye cannot focus to said line which becomes dim. If the end of the wedge prisms along the

line Ií is not formed sharply but by a narrow edge surface - this is advantageous when grinding the prisms to eliminate chipping -, the plane of said edge surface should pass through the central point K of the eyeball, because in this case the forward looking eye focuses said edge surface on the eyeground (on the spot of the keen sight) as a line. However, the pupil of an eyeball turned to the side sees said edge surface a little from the side, in such a manner that said surface is focused on the retina as a stripe, which can be somewhat disturbing. The line Ií or the above mentioned edge surface is called jointly the optically effective edge of the optical element in question.

The wedge prisms 3, 4 and the screens 1, 2 are arranged in the space relative to each other and the central point K of the eyeball in such a manner that the light paths starting from the bigger part OPÓQ of the screen 1 beyond the joining line PQ and arriving in the central point K of the eyeball define a polyhedron KAÉGOPIBÁFHÓQÍC; and the light paths starting from the bigger part UVYZ of the screen 2 beyond the joining line UV and reaching the central point K of the eyeball define another polyhedron KDJMYUIBELNZVÍC; the sections of said polyhedrons between the wedge prism 3 and the centre K, on one side, and the wedge prism 4 and the centre K, on the other side, touch each other along a plane that contains the optically effective edges Ií and the centre K of the eyeball. A focusing element

13a extending over the full cross section of the light paths is placed between the centre K of the eyeball and the primary optical element(s), i.e. the wedge prisms 3 and 4. The focusing element consist of a magnifying lens or lens system.

Fig. 9 shows how pictures on two screens can be united by a single wedge prism for each eye. Accordingly, two adjoining screens 7 and 8 are arranged in front of the left eyeball 5, and a wedge prism 11 is placed in the light path between the screen 7 and the pupil P_5 in such a manner that its optically effective edge is in contact with the plane defined by the joining line of the other screen 8 and the centre K_5 of the eyeball 5, and the angles between the optically effective surfaces of said wedge prism 11 and the plane of the corresponding screen 7 are smaller than 20°; similarly, two adjoining screens 9 and 10 are arranged in front of the right eyeball 6, and a wedge prism 12 is placed in the light path between the screen 10 and the pupil P6 in such a manner that its optically effective edge is in contact with the plane defined by the joining line of the other screen 9 and the centre K_6 of eyeball 6, and the angles between the optically effective surfaces of said wedge prism 12 and the plane of the corresponding screen 10 are smaller than 20°. A focusing element 13 is arranged in front of the eyeball 5; the optical axis of said focusing element 13 is identical with the straight line connecting the centre K_5 of the eyeball 5 with the middle

of the joining line of the screen 8. Similarly, a focusing element 14 is arranged in front of the eyeball 6; the optical axis of said focusing element 14 is identical with the straight line connecting the centre K_6 of the eyeball 6 with the middle of the joining line of the screen 9. The angle between the optical axes of said focusing elements 13 and 14 is smaller than 15°.

Fig. 10 shows how pictures of four screens can be united by means of four wedge prisms. In this case, four screens are arranged in the same plane simmetrically to a horizontal and a vertical axis, in front of both the left eye and the right eye. A first wedge prism 17 is inserted in the light path between the two upper screens 15 and 16 and the centre K of the eyeball; and a second wedge prism 20 is inserted in the light path between the two lower screens 18 and 19 and the centre K of the eyeball. The wedge prisms 17, 20 touch each other along their optically effective edges, i.e. refracting edges, and their base surfaces are turned to the opposite directions; said prisms are arranged in such a manner that their refracting edges are parallel to the horizontal axis, one of the optically effective surfaces of each prism is in a common plane, called main plane, which is parallel to the plane of the screens; the other optically effective surface of each prism forms an angle with the main plane, which angle opens toward the screens. A third wedge prism 21 is inserted in the light path between the two left side screens 15 and

18 and the centre K of the eyeball; and a fourth wedge prism 22 is inserted in the light path between the two right side screens 16 and 19 and the centre K of the eyeball. These wedge prisms 21, 22 touch each other along their optically effective edges, i.e. refracting edges, and their base surfaces are turned to the opposite directions; said prisms are arranged in such a manner that their refracting edges are parallel to the vertical axis, one of the optically effective surfaces of each prism is in a common plane, which is the main plane; the intersection Q of the horizontal and vertical axes, the intersection R of the horizontal and vertical optically effective edges (here refracting edges) of the wedge prisms, the optical axis of the focusing element 23 and the centre K of the eyeball are placed along a straight line being perpendicular to the plane of the screens 15, 16, 18, 19. The wedge prisms 17, 20, 21, 22 can be made of glass or a transparent plastic material, they can be stuck together by an optical adhesive, or even they can be formed as a single transparent body.

Fig. 11 shows how the pictures of two screens can be united by a plane mirror for each eye. In this case, two separate (not adjoining) screens 24 and 25 belong to the left eyeball 5; in the light path between the screen 24 and the pupil P_5, a plane mirror 26 is placed in such a manner that its optically effective edge is in a plane defined by the joining line of the other screen 25 and the

centre K_5 of the eyeball 5, and its reflecting surface forms an angle of ß/2 with said plane, while the reflected screen 24 forms an angle of 180°-ß with the plane of the other screen 25. Similarly, two separate (not adjoining) screens 27 and 28 belong to the right eyeball 6; in the light path between the screen 27 and the pupil P_6, a plane mirror 29 is placed in such a manner that its optically effective edge is in a plane defined by the joining line of the other screen 28 and the centre K_6 of the eyeball 6, and its reflecting surface makes an angle of ω/2 with said plane, while the reflected screen 27 forms an angle of 180°-ω with the plane of the other screen 28. In front of the eyeball 5, a focusing element 30 is placed, the optical axis of which coincides with the straight line connecting the centre K_5 of the eyeball 5 with the middle of the joining line of the screen 25. In like manner, a focusing element 31 is placed in front of the eyeball 6, the optical axis of which coincides with the straight line connecting the centre K6 of the eyeball 6 with the middle of the joining line of the screen 28. The angle between the optical axes of he focusing elements 30 and 31 is smaller than 15°.

Fig. 12 shows how the pictures of two screens can be united by two plane mirrors for each eye. In this case, two separate (not adjoining) screens 32 and 33 belong to the left eyeball 5; in each of the two light paths between the two screens 32, 33 and the pupil P_5, a plane mirror 34 and 35, respectively, is

placed in such a manner that their optically effective edges coincide and perpendicularly intersect the straight line passing through the centre K_5 of the eyeball 5 and coinciding with the optical axis of the focusing element 36 placed in front of the eyeball 5. The plane mirrors 34 and 35 form an angle γ and δ, respectively, with said straight line, while the corresponding screens 32 and 33 form angles of $90°-\gamma$ and $90°-\delta$, respectively, with the plane mirrors 34 and 35. Similarly, two separate (not adjoining) screens 37 and 38 belong to the right eyeball 6; in the light path between the screen 37 and the pupil P_6, a plane mirror 39, while in the light path between the screen 38 and the pupil P_6, a plane mirror 40 is placed in such a manner that their optically effective edges coincide and perpendicularly intersect the straight line passing through the centre K6 of the eyeball 6 and coinciding with the optical axis of the focusing element 41 placed in front of the eyeball 6. The plane mirrors 39 and 40 make an angle ε and τ, respectively, with said straight line, while the corresponding screens 37 and 38 form angles of $90°-\varepsilon$ and $90°-\tau$, respectively, with the plane mirrors 39 and 40. The angle between the optical axes of the focusing elements 30 and 31 is smaller than 15°.

Fig. 13 shows how the pictures of two screens can be united by two magnifying lenses for each eye. In this case, two adjoining screens 42 and 43 are placed in front of the left eyeball 5; in each of the two light paths

between the two screens 42, 43 and the pupil P_5, a magnifying lens 44 and 45, respectively, is placed as a primary optical element in such a manner that their optically effective edges coincide and perpendicularly intersect the straight line passing through the centre K_5 of the eyeball 5 and coinciding with the optical axis of the focusing element 46 placed in front of the eyeball 5. The optical main planes of said magnifying lenses 44, 45 coincide with each other, while their optical centres flush with the plane defined by the centre K_5 of the eyeball 5, the centre of the screen 42 and the centre of the screen 43. Similarly, two adjoining screens 47 and 48 are placed in front of the right eyeball 6; in each of the two light paths between the two screens 47, 48 and the pupil P_6, a magnifying lens 49 and 50, respectively, is placed as a primary optical element in such a manner that their optically effective edges coincide and perpendicularly intersect the straight line passing through the centre K_6 of the eyeball 6 and coinciding with the optical axis of the focusing element 51 placed in front of the eyeball 6. The optical main planes of said magnifying lenses 49, 50 coincide with each other, while their optical centres flush with the plane defined by the centre K_6 of the eyeball 6, the centre of the screen 47 and the centre of the screen 48. The angle between the optical axes of the focusing elements 46 and 51 is smaller than 15°.

Fig. 14 shows how pictures of four screens can be united by means of four magnifying

lenses. In this case, four screens are arranged in front of both the left and the right eye in the same plane, simmetrically to a horizontal and a vertical axis. In each of the four light paths between the four screens 52, 53, 54, 55 and the pupil, a magnifying lens 56, 57, 58, 59 is placed as primary optical element. The magnifying lenses 56, 57, 58, 59 touch each other along their optically effective edges. The intersection D of the horizontal and vertical axes, the intersection F of the horizontal and vertical optically effective edges of the magnifying lenses 56, 57, 58, 59, the optical axis of the focusing element 60 and the centre K of the eyeball are placed along a straight line.

Fig. 15 shows another embodiment of the arrangement according to Fig. 8. The LCD screens 63 and 64 transilluminated by electrofluorescent lamps 61 and 62 are placed in adjoining covers 65 and 66 fixed - together with wedge prisms 67 and 68 as primary optical elements, magnifying lenses 69 and 70, and a focusing element 71 formed by a lens system of two members - to a frame 72. Similarly, the LCD screens 75 and 76 transilluminated by electrofluorescent lamps 73 and 74 are placed in adjoining covers 77 and 78 fixed - together with wedge prisms 79 and 80 as primary optical elements, magnifying lenses 81 and 82, and a focusing element 83 formed by a lens system of two members - to a frame 84. The frames 72 and 84 are surrounded by a housing 85 which has openings facing the eyeballs 5 and 6 for

looking into. The frames 72 and 84 can be shifted inside the housing 85 along a constraint path parallel to a straight line connecting the centres K_5 and K_6, and thereby they can be set in front of the pupils P_5 and P_6. The housing 85 is fixed to the head by a band, a band system or a helmet (not shown in the drawing).

Fig. 16 illustrates an embodiment of the devices according to Fig. 15. In this embodiment, the rays of light are bent by mirrors to achieve a compact arrangement of the elements in a housing 86 sitting close to the forehead, which is more advantageous and aesthetical than the housing 85 protruding horizontally in front of the eyes.

According to Figs. 16 and 17, the lower mirror 87 on the left side is arranged in the light path between the left side focusing element 88 and the wedge prisms 89, 90, and forms an angle of about 45°, preferably 45°±15°, with the optical axis of the left side focusing element 88. The upper mirror 91 on the left side is arranged in the light path between the lenses 92, 93 and the screens 96, 97 transilluminated by the lamps 94 and 95, respectively, and forms an angle of about 45°, preferably 45°±15°, with the plane of the screens 96, 97. The elements on the right side of the head 109 are arranged similarly. The lower mirror 98 on the right side is arranged in the light path between the right side focusing element 99 and the wedge prisms 100, 101, and forms an angle of about 45°,

preferably 45°±15°, with the optical axis of the right side focusing element 99. The upper mirror 102 on the right side is arranged in the light path between the lenses 103, 104 and the screens 107, 108 transilluminated by the lamps 105 and 106, respectively, and forms an angle of about 45°, preferably 45°±15°, with the plane of the screens 107, 108. The elements on the left side of the head 109 are fixed together by a rigid frame 110 fitted with a clearance into the housing 111; said frame 110 can be shifted parallel to the straight line connecting the pupils. Similarly, the elements on the right side of the head 109 are fixed together by a rigid frame 112 fitted with a clearance into the housing 111; said frame 112 can be shifted parallel to the straight line connecting the pupils.

Fig. 18 is a perspective view showing the embodiment according to Figs. 16 and 17 fixed to the head 109. According to the drawing, the housing 111 is placed in front of the eyes and the forehead; a band 113 running around the head 109 is fixed to both ends of said housing. The band 113 is hollow for placing the electric wiring. A loudspeaker (earphone) 114 is placed over the left ear in the downwards widened part of said band. Another loudspeaker (not shown) is placed similarly over the right ear. Another headband 116 is fixed to the band 113 by means of joints to distribute the load on the head and partly relieve the ridge of nose, which is sensitive to the load. A cable 117 connects the band 113 with an operating unit (not shown)

transmitting the video signal, the sound signal and the supply voltage to the head worn unit.

The operating unit can be e.g. a computer, video camera, video recorder or television receiver. In a preferred embodiment, the operating unit is a computer transmitting several consecutive details of a programmed "virtual reality" landscape to the head worn unit; said details correspond to the looking angle of both the left eye and the right eye; the transmission occurs in the form of video signals, the number of which corresponds to the number of the screens. If appropriately detailed and realistic pictures are programmed, the device according to the invention assures that the spectacle appearing seemingly on a giant panorama screen seen at a distance of about 3 to 6 metres and at a visual angle of about 60° to 100°, depending on the setting, presents an extraordinary experience of reality, the viewer enters virtually into the represented strange space of three dimensional effect.

What is claimed is:

1. Head worn stereoscopic display device, particularly for displaying television pictures, comprising
picture display means and optical elements fixed to a common frame; and
electronic connections to video signal sources, c h a r a c t e r i z e d in that more than one, preferably two or four screens belong to both the left and the right eye; the picture columns of said screens are parallel to each other; said screens display the full picture in parts with overlapping edges; the boundary of the overlapping parts of the pictures is parallel to the edges of the pictures; the width of the overlapping zones of the pictures amounts to 10-50 % of the total width of the screen; primary optical elements, particularly wedge prisms, plane mirrors or lenses, directing the light paths side by side are arranged in one or every one of the light paths starting from the bigger part of the screens beyond the middle picture equivalent line, called joining line, and arriving in the central point of the corresponding eyeball, in such a manner that they have an optically effective edge running parallel to the joining line of the overlapping picture zone, said optically effective edge is sharp or it seems as a line for the eye looking at, because it is a narrow edge surface, the plane of which passes through the central point of the

eyeball; said primary optical elements and screens are arranged in the space relative to each other and the central point of the eyeball in such a manner that the light paths starting from the bigger part of the screens beyond the joining line and arriving in the central point of the eyeball, define polyhedrons having sections between said primary optical element(s) and the centre of the eyeball touching each other along a plane or planes containing the optically effective edge(s) and the centre of the eyeball; and a focusing element, preferably magnifying lens or lens system, extending over the full cross section of the light paths is placed in front of the eyeballs, perpendicularly to said plane(s).

2. Device as claimed in claim 1, c h a r a c t e r i z e d in that further mirrors or wedge prisms for bending, and lenses for focusing the light paths are arranged in any section of said light paths.

3. Device as claimed in claim 1 or 2, c h a r a c t e r i z e d in that a pair of screens (63, 64 and 75, 76, respectively) arranged side by side is placed in front of each eyeball (5 and 6); two wedge prisms (67, 68) touching along their refracting edges and having base surfaces turned to the opposite directions are arranged between the left eyeball (5) and the two screens (63, 64) facing said eyeball (5); and similarly, two wedge prisms (79, 80) touching along their refracting edges and

having base surfaces turned to the opposite directions are arranged between the right eyeball (6) and the two screens (75, 76) facing said eyeball (6).

4. Device as claimed in any one of claims 1 to 3, characterized in that a magnifying lens (69, 70, 81, 82) is arranged in the light path between the optically effective surface of each wedge prism (67, 68, 79, 80) and the corresponding screens (63, 64, 75, 76).

5. Device as claimed in any one of claims 1 to 4, characterized in that a lower left side mirror (87) is arranged in the light path between the left side focusing element (88) and the wedge prisms (89, 90), and the plane of said mirror (87) forms an angle of 45°±15° with the optical axis of the left side focusing element (88); and similarly, a lower right side mirror (98) is arranged in the light path between the right side focusing element (99) and the wedge prisms (100, 101), and the plane of said mirror (98) forms an angle of 45°±15° with the optical axis of the right side focusing element (99); and an angle between the lower left side mirror (87) and the lower right side mirror (98) is not larger than 15°

6. Device as claimed in any one of claims 1 to 4, characterized in that an upper left side mirror (91) is arranged in the light path between the left side wedge prisms (89, 90) and the left side screens (96, 97), said

upper left side mirror (91) and the lower left side mirror (87) form an angle not larger than 15°; and similarly, an upper right side mirror (102) is arranged in the light path between the right side wedge prisms (100, 101) and the right side screens (107, 108), said upper right side mirror (102) and the lower right side mirror (98) form an angle not larger than 15°; and the upper left side mirror (91) and the upper right side mirror (102) form an angle not larger than 15°.

7. Device as claimed in any one of claims 1 to 4, characterized in that the left side screens (63, 64), the transilluminating lamps (61, 62) and the magnifying lenses (69, 70), the wedge prisms (67, 68) and the left side focusing element (71) are fixed together by means of a rigid frame (72); and similarly, the right side screens (75, 76), the transilluminating lamps (73, 74) and the magnifying lenses (81, 82), the wedge prisms (79, 80) and the right side focusing element (83) are fixed together by means of a rigid frame (84); the rigid frames (72, 84) and said elements fixed to said frames are surrounded by a housing (85) having openings for looking into; said rigid frames (72, 84) can be shifted inside said housing (85) along a constraint path parallel to a straight line connecting the centre (K_5) of the left side eyeball (5) and the centre (K_6) of the right side eyeball (6).

8. Device as claimed in any one of claims 1 to 6, characterized in that the left side screens (96, 97), the transilluminating lamps (94, 95) belonging to said screens, the upper left side mirror (91), the left side magnifying lenses (92, 93), the left side wedge prisms (89, 90), the lower left side mirror (87) and the left side focusing element (88) are fixed together by means of a rigid frame (110); and similarly, the right side screens (107, 108), the transilluminating lamps (105, 106) belonging to said screens, the upper right side mirror (102), the right side magnifying lenses (103, 104), the right side wedge prisms (100,101), the lower right side mirror (98) and the right side focusing element (99) are fixed together by means of a rigid frame (112); the rigid frames (110, 112) and said elements fixed to said frames are surrounded by a housing (111) having openings at the eyeballs; said rigid frames (110, 112) can be shifted inside said housing (111) along a constraint path parallel to a straight line connecting the centres of the eyeballs.

9. Device as claimed in claim 1, characterized in that two adjoining screens (7, 8) are arranged in front of the left eyeball (5), and a wedge prism (11) is placed in the light path between one screen (7) and the centre (K_5) of the eye in such a manner that its optically effective edge is in contact with the plane defined by the joining line of the other screen (8) and the centre (K_5) of the

left eyeball (5), and the angles between the optically effective surfaces of said wedge prism (11) and the plane of the screens (7, 8) are smaller than 20°; similarly, two adjoining screens (9, 10) are arranged in front of the right eyeball (6), and a wedge prism (12) is placed in the light path between one screen (10) and the centre (K_6) of the eyeball (6) in such a manner that its optically effective edge is in contact with the plane defined by the joining line of the other screen (9) and the centre (K_6) of the eye, and the angles between the optically effective surfaces of said wedge prism (12) and the plane of the screens (9, 10) are smaller than 20°.

10. Device as claimed in claim 1, c h a r a c t e r i z e d in that four screens are arranged in front of both the left side eye and the right side eye in the same plane, simmetrically to a horizontal and a vertical axis; a first wedge prism (17) is inserted in the light path between the two upper screens (15, 16) and the centre (K) of the eyeball; and a second wedge prism (20) is inserted in the light path between the two lower screens (18, 19) and the centre (K) of the eyeball; said wedge prisms (17, 20) touch each other along their optically effective edges, i.e. refracting edges, and their base surfaces are turned to the opposite directions; said wedge prisms (17, 20) are arranged in such a manner that their refracting edges are parallel to the horizontal axis, one of the optically effective

surfaces of each prism is in a common plane, called main plane, which is parallel to the plane of the screens (15, 16, 18, 19), the other optically effective surface of each prism and the main plane form an angle opening toward the screens; a third wedge prism (21) is inserted in the light path between the two left side screens (15, 18) and the centre (K) of the eyeball; and a fourth wedge prism (22) is inserted in the light path between the two right side screens (16, 19) and the centre (K) of the eyeball; these wedge prisms (21, 22) touch each other along their optically effective edges, i.e. refracting edges, and their base surfaces are turned to the opposite directions; said wedge prisms (21, 22) are arranged in such a manner that their refracting edges are parallel to the vertical axis, one of the optically effective surfaces of each prism is in a common plane, which is the main plane; the intersection (Q) of the horizontal and vertical axes, the intersection (R) of the horizontal and vertical refracting or optically effective edges, the optical axis of the focusing element (23) and the centre (K) of the eyeball are placed along a straight line being perpendicular to the main plane.

11. Device as claimed in claim 1, c h a r a c t e r i z e d in that two screens (24, 25) belong to the left side eyeball (5); a plane mirror (26) is placed in the light path between one screen (24) and the centre (K_5) of the eyeball in such a manner that its optically

effective edge is in the plane defined by the joining line of the other screen (25) and the centre (K_5) of the eyeball, and its reflecting surface makes an angle of $\beta/2$ with said plane, while the corresponding screen (24) forms an angle of $180°-\beta$ with the plane of the other screen (25); and similarly, two screens (27, 28) belong to the right side eyeball (6); a plane mirror (29) is placed in the light path between one screen (27) and the centre (K_6) of the eyeball in such a manner that its optically effective edge is in a plane defined by the joining line of the other screen (28) and the centre (K_6) of the eyeball (6), and its reflecting surface makes an angle of $\omega/2$ with said plane, while the corresponding screen (27) forms an angle of $180°-\omega$ with the plane of the other screen (28).

12. Device as claimed in claim 1, c h a r a c t e r i z e d in that two screens (32, 33) belong to the left side eyeball (5); a plane mirror (34, 35) is placed in each of the two light paths between the two screens (32, 33) and the centre (K_5) of the eyeball (5) in such a manner that their optically effective edges coincide and perpendicularly intersect the straight line passing through the centre (K5) of the eyeball (5) and coinciding with the optical axis of the focusing element (36); the plane mirrors (34, 35) make an angle γ and δ, respectively, with said straight line, while the corresponding screens (32, 33) form angles of $90°-\gamma$ and $90°-\delta$, respectively, with the

plane of the plane mirrors (34, 35); and similarly, two screens (37, 38) belong to the right side eyeball (6); a plane mirror (39, 40) is placed in each of the two light paths between the two screens (37, 38) and the centre (K_6) of the eyeball (6) in such a manner that their optically effective edges coincide and perpendicularly intersect the straight line passing through the centre (K_6) of the eyeball (6) and coinciding with the optical axis of the focusing element (41); the plane mirrors (39, 40) make an angle ε and τ, respectively, with said straight line, while the corresponding screens (37, 38) form angles of $90°-\varepsilon$ and $90°-\tau$, respectively, with the plane mirrors (39, 40).

13. Device as claimed in claim 1, c h a r a c t e r i z e d in that a magnifying lens (44, 45) is placed as a primary optical element in each of the two light paths between the two left side screens (42, 43) and the centre (K_5) of the left eyeball (5) in such a manner that their optically effective edges coincide and perpendicularly intersect the straight line passing through the centre (K_5) of the eyeball (5) and coinciding with the optical axis of the focusing element (46); the optical main planes of said magnifying lenses (44, 45) coincide with each other, while their optical centres flush with the plane defined by the centres of the screens (42, 43) and the centre (K_5) of the eyeball (5); and similarly, a magnifying lens (49, 50) is placed as a primary optical element

in each of the two light paths between the two right side screens (47, 48) and the centre (K_6) of the right eyeball (6) in such a manner that their optically effective edges coincide and perpendicularly intersect the straight line passing through the centre (K_6) of the eyeball (6) and coinciding with the optical axis of the focusing element (51), the optical main planes of said magnifying lenses (49, 50) coincide with each other, while their optical centres flush with the plane defined by the centres of the screens (47, 48) and the centre (K_6) of the eyeball (6).

14. Device as claimed in claim 1, c h a r a c t e r i z e d in that four screens (52, 53, 54, 55) are arranged in front of both the left and the right eye in the same plane, simmetrically to a horizontal and a vertical axis; in each of the four light paths between the four screens (52, 53, 54, 55) and the centre (K) of the eyeball, a magnifying lens (56, 57, 58, 59) is placed as primary optical element, said magnifying lenses (56, 57, 58, 59) touch each other along their optically effective edges; and the intersection (D) of the horizontal and vertical axes, the intersection (F) of the horizontal and vertical optically effective edges of the magnifying lenses (56, 57, 58, 59), the optical axis of the focusing element (60) and the centre (K) of the eyeball are placed along a straight line.

15. Device as claimed in any one of claims 1 to 14 , c h a r a c t e r i z e d in that the optically effective edge of the primary optical elements is nearer to the pupil than 5 cm.

16. Device as claimed in any one of claims 1 to 15 , c h a r a c t e r i z e d in that the housing (111) containing the screens and the optical elements is provided with a hollow band (113) running around the head (109) and having a loudspeaker (114) near the left ear and another loudspeaker near the right ear; the two sides of said band (113) are connected by another headband (116) fixed to said band (113) by means of joints (115) and running round on the top of the head (109).

17. Device as claimed in any one of claims 1 to 16 , c h a r a c t e r i z e d in that the screens and the loudspeakers are electronically connected to a computer by means of a cable (117), said computer producing video signals, the number of which corresponds to the number of the screens, and a monophonic or stereophonic sound signal.

AMENDED CLAIMS

[received by the International Bureau on 24 March 1997 (24.03.97); original claim 1 amended; remaining claims unchanged (2 pages)]

Head worn stereoscopic display device, particularly for displaying television pictures, comprising

- screens and optical elements fixed to a holder means, particularly to a common frame, and electronic connections for video signal sources, said screens having a rectangular shape, the corners of which being rounded-off in given case;

- more than one, preferably two or four screens belong separately to both the left and the right eye of the user of said device, said screens displaying parts of a full picture with overlapping edges, and the corresponding edges of the pictures appearing on said screens are parallel to each other, and the boundary/boundaries of the overlapping zone(s) of said pictures is/are parallel to the edges of the pictures; and

- the width/height of said overlapping zone(s) of said pictures amount(s) to about 10-50% of the total width/height of each screen; said stereoscopic display device

c o m p r i s i n g

- primary optical elements for each eye of the user, particulary wedge prism(s), and/or plane mirror(s), and/or lens(es) having optically effective edge(s) parallel to the bisector ("picture equivalent line" or "joining line") of said overlapping zone(s);

- said primary optical element(s) directing light paths (light beams) side by side; said light paths starting from the bigger part of screens and extending to the central point (K) of user's eyeball

belonging to said screens; said bigger part of screens extending to the bisector of said overlapping zone(s);

- said light paths containing a polyhedron-shaped part extending between the primary optical element(s) and the central point (K) of the user's eyeball; and said primary optical element(s) and screens being arranged in relation to each other and to the central point (K) of the given eyeball in such a way, that the polyhedron-shaped parts of said light paths are touching each other along a plane or planes containing the optically effective edge(s) of said primary optical element(s) and the central point (K) of the eyeball; and

- a lupe or lupe-system being arranged between each eyeball and the primary optical element(s) belonging to this eyeball, said lupe or lupe-system being perpendicular to said plane(s) extending over the full cross-section of said polyhedron-shaped parts of said light paths (Fig. 8 and Fig. 14).

2. Device as claimed in claim 1, c h a r a c t e r i z e d in that further mirrors or wedge prisms for beinding, and lenses for focusing the light paths are arranged in any section of said light paths.

3. Device as claimed in claim 1 or 2, c h a r a c t e r i z e d in that a pair of screens (63, 64 and 75, 76, respectively) arranged side by side is placed in front of each eyeball (5 and 6); two wedge prisms (67, 68) touching along their refracting edges and having base surfaces turned to the opposite directions are arranged between the left eyeball (5) and the two screens (63, 64) facing said eyeball (5); and similarly, two wedge prisms (79, 80) touching along their refracting edges and

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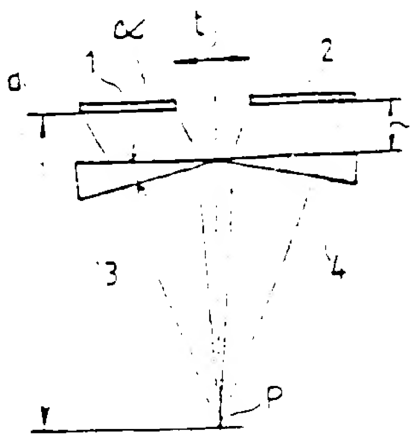

Fig.1

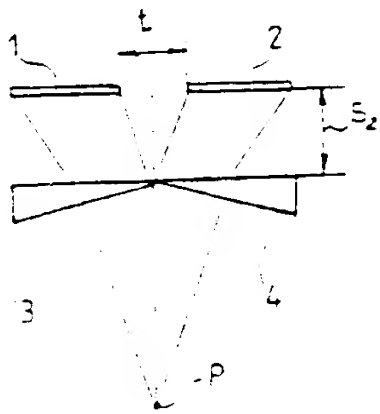

Fig. 2

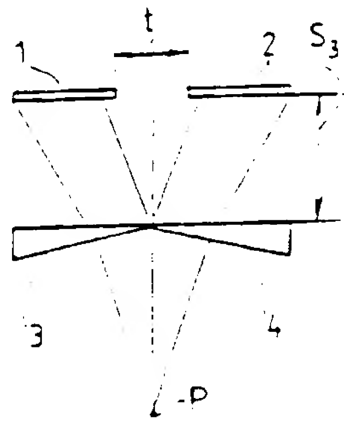

Fig.3

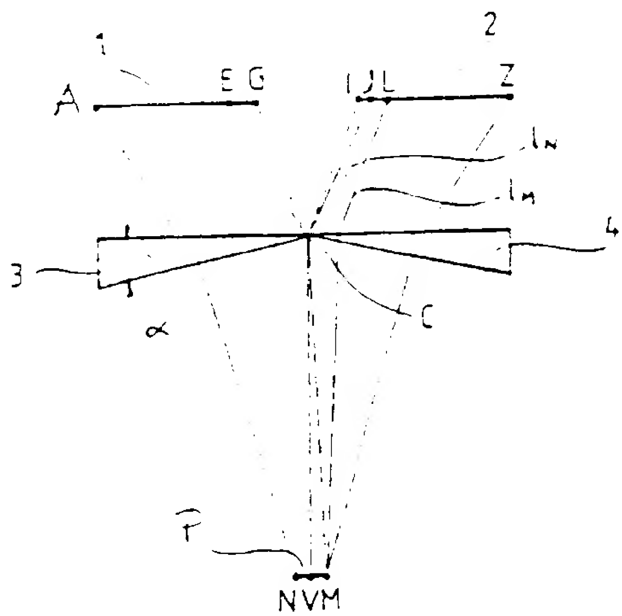

Fig.4

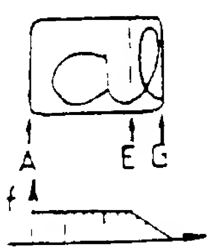

Fig 5.

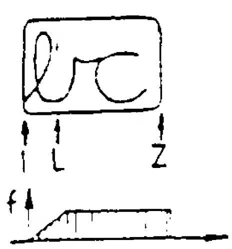

Fig 6.

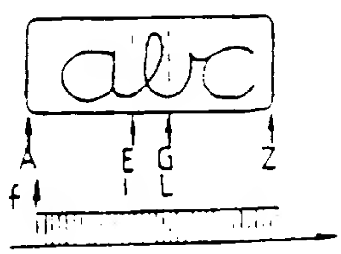

Fig. 7

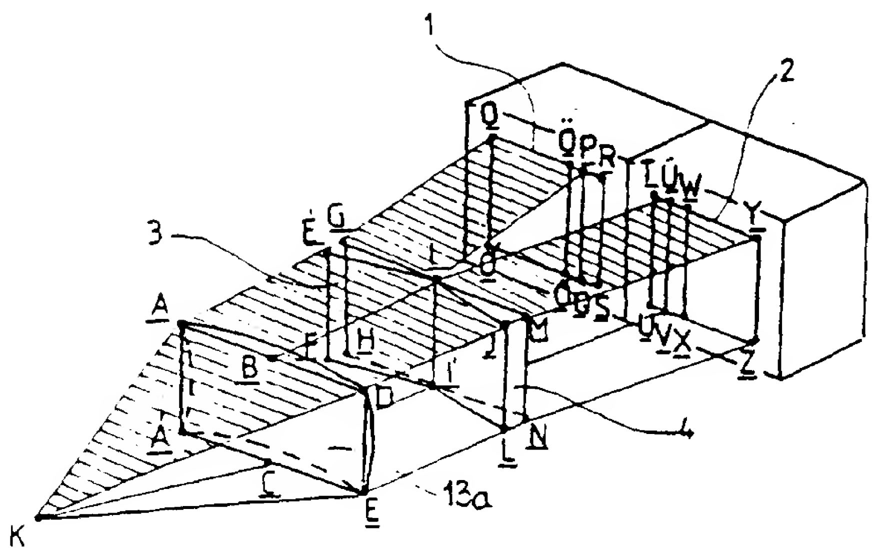
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Fig. 8

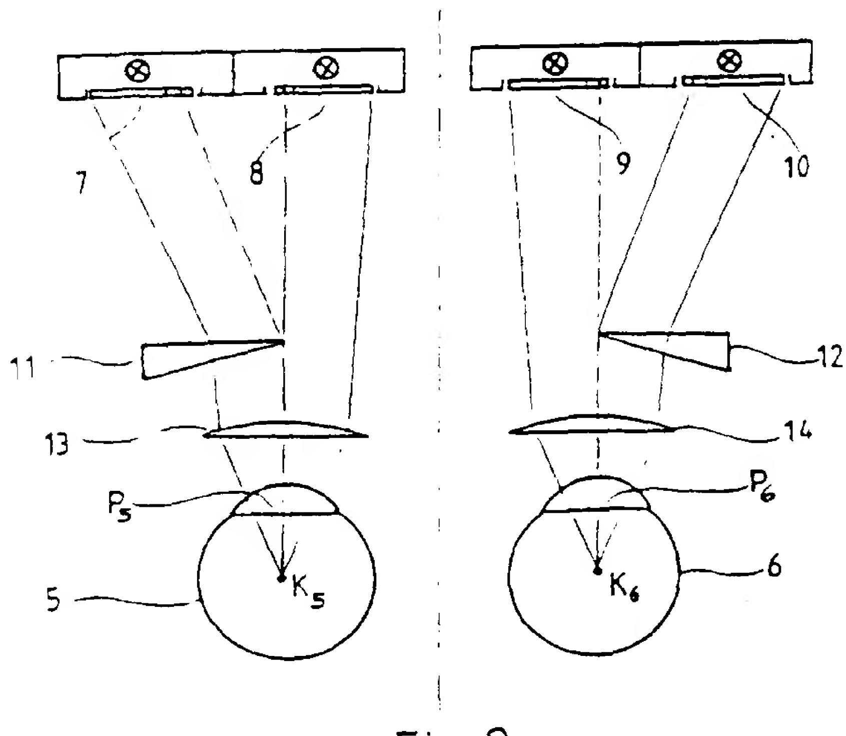
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Fig. 9

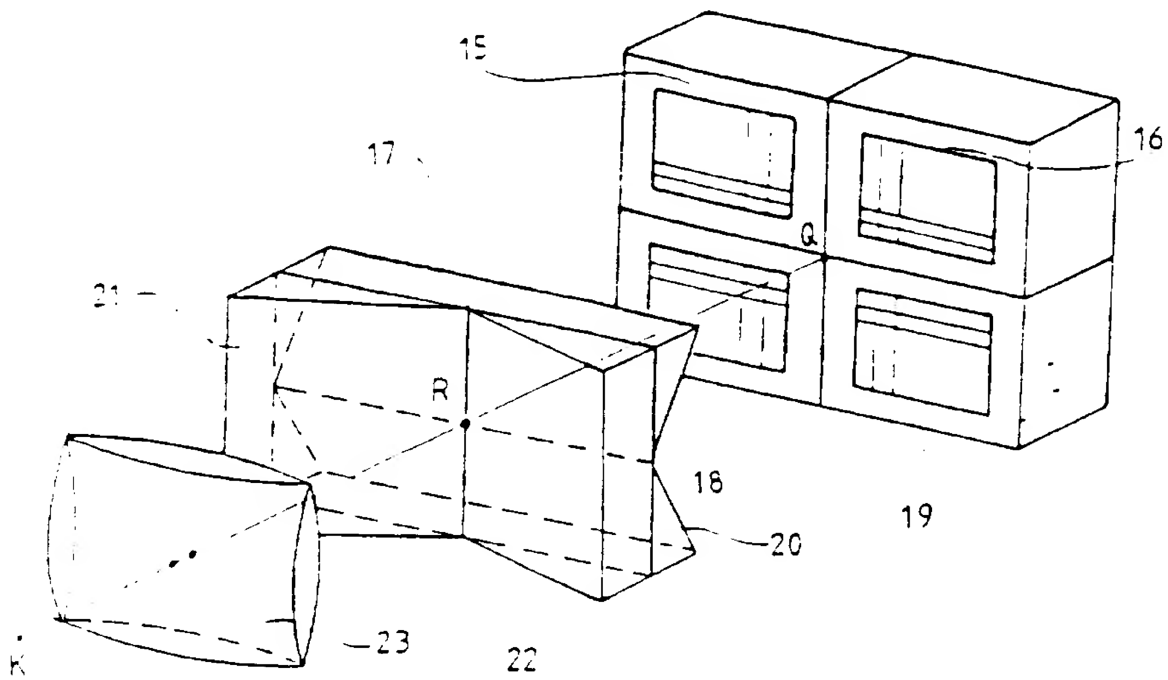
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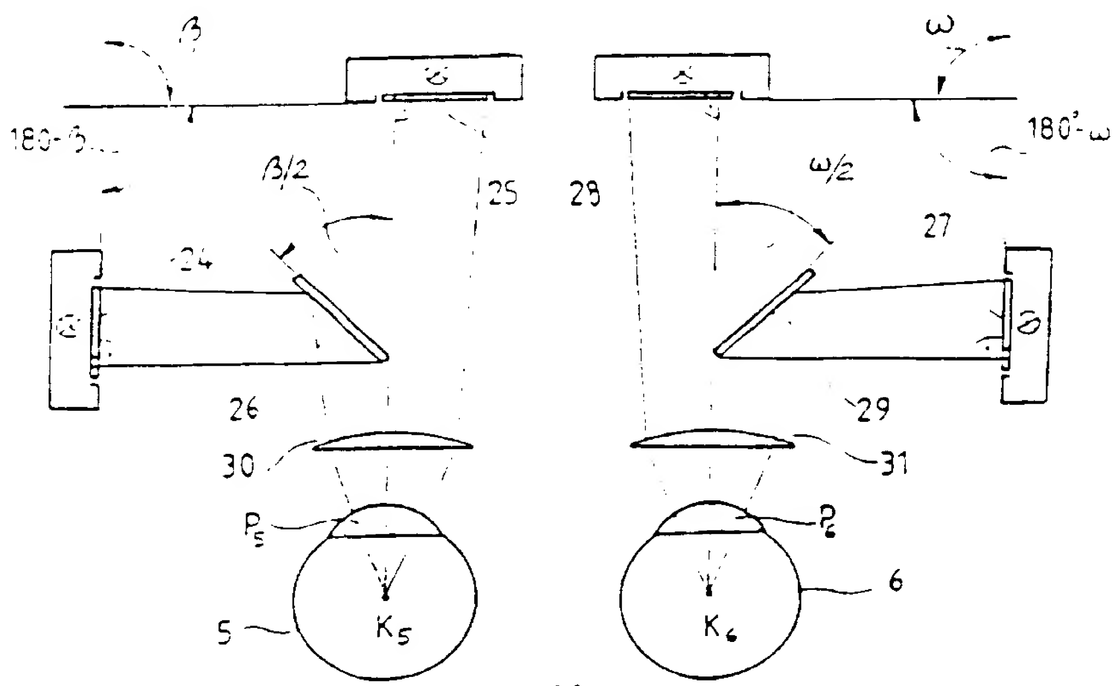
Fig 10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ω/2
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K_5
K_6

Fig.11

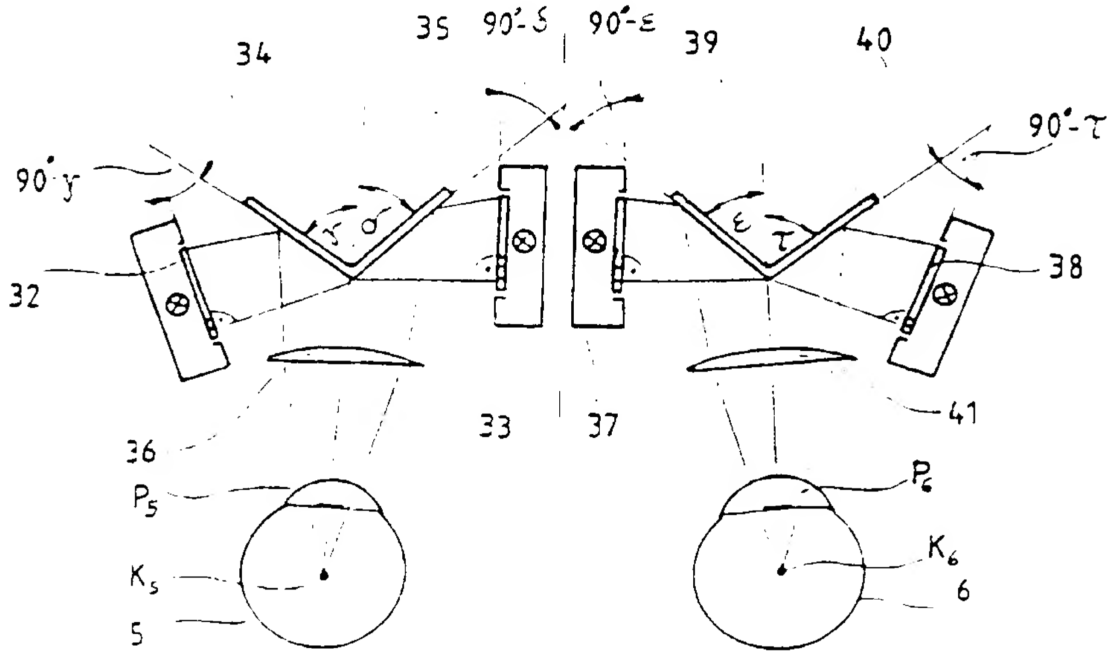
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Fig 12

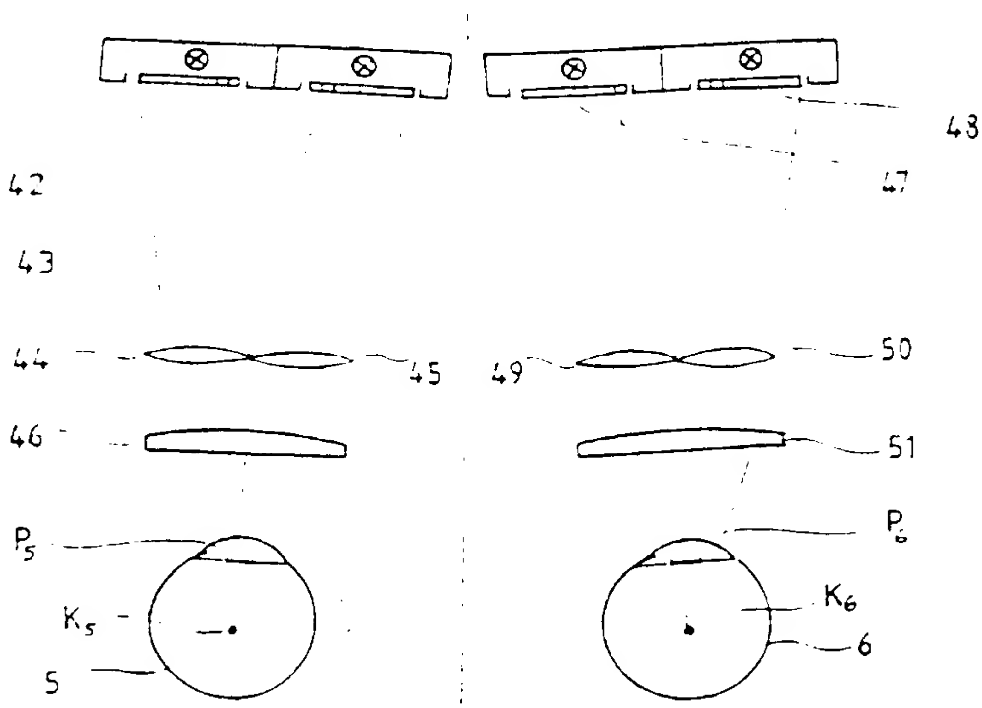
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Fig 13

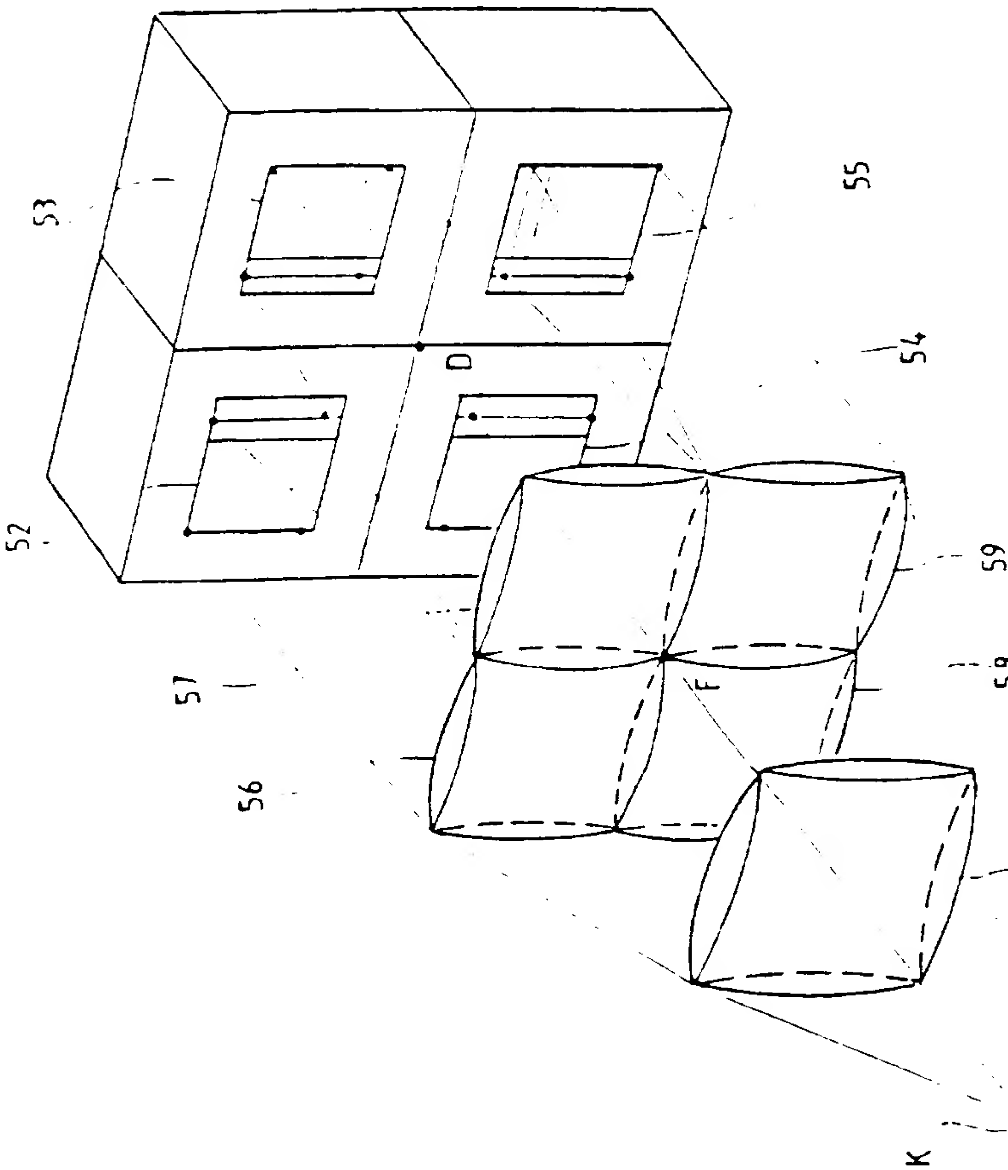

Fig 14

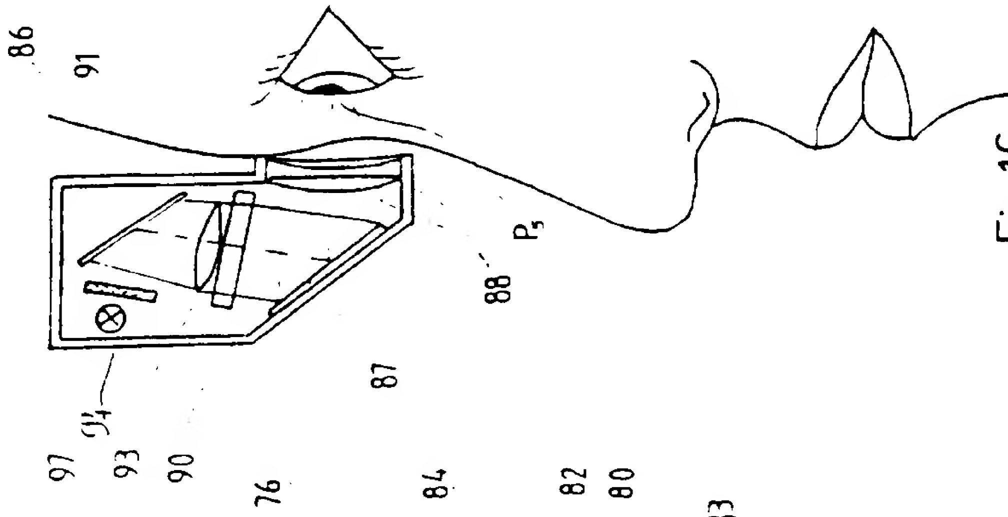
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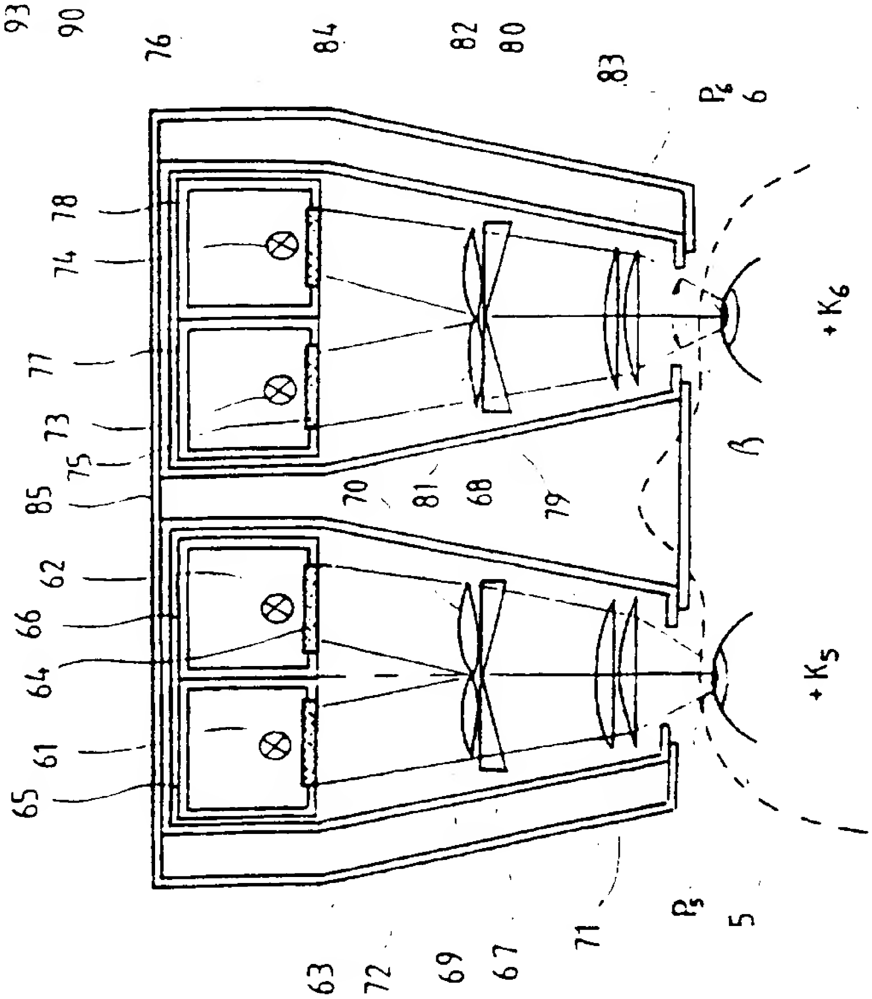
Fig16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$+K_6$
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P_5
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Fig.15

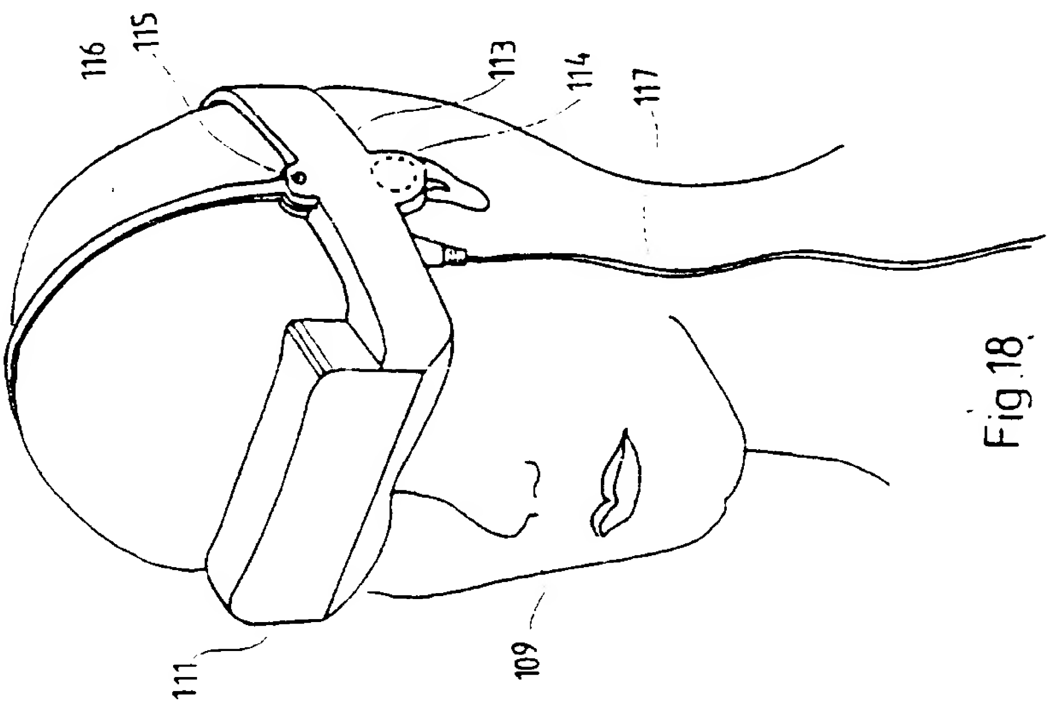
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Fig.18

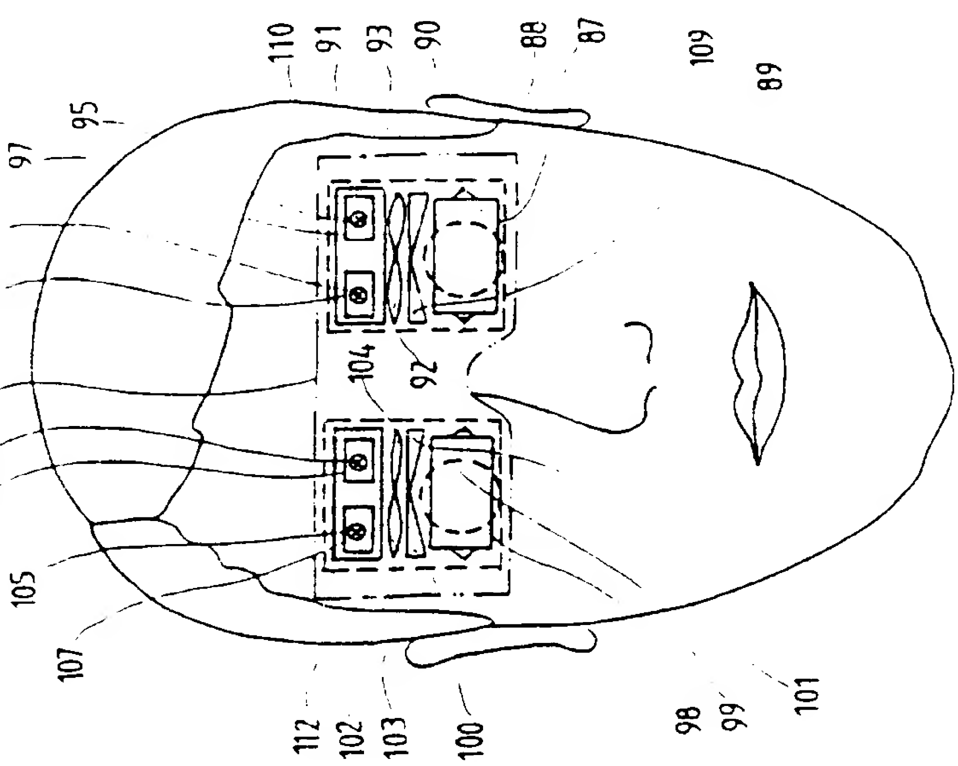
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Fig.17

INTERNATIONAL SEARCH REPORT

International Application No
PCT/HU 96/00051

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G02B27/01 H04N5/57

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G02B H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X	EP,A,0 618 471 (CANON) 5 October 1994 see column 1, line 5 - line 13	1
A	see column 14, line 33 - column 16, line 26; figures 2,10	11
Y	US,A,5 123 726 (WEBSTER) 23 June 1992 cited in the application see abstract	1
Y	WO,A,92 08319 (METAVISION CORPORATION) 14 May 1992	1
A	see page 7, line 19 - page 8, line 10; figure 2	3
A	DE,A,34 24 877 (BOSCH) 6 February 1986 see page 6, paragraph 1 - paragraph 2; figure 1	1,13,14

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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3

Date of the actual completion of the international search	Date of mailing of the international search report
2 January 1997	10.01.97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Soulaire, D

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International Application No
PCT/HU 96/00051

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,5 130 794 (RITCHEY) 14 July 1992 see column 9, line 27 - line 40; figure 47	1,14,16, 17
A	US,A,4 588 382 (PETERS) 13 May 1986 see column 4, line 37 - line 52; figure 7A	1-4
A	EP,A,0 471 478 (MITSUBISHI) 19 February 1992 see page 3, line 27 - line 33 see page 4, line 31 - line 34; figure 2	1,10
A	DE,A,14 06 528 (BENDIX) 31 October 1968 see page 9, paragraph 2; figure 5	2-4,9, 10,13,14
A	US,A,5 371 556 (SUWA) 6 December 1994 cited in the application see column 3, line 29 - line 55; figure 3 see column 4, line 10 - line 22; figure 6	7,8,16
A	EP,A,0 582 229 (CANON) 9 February 1994 see page 5, line 52 - page 6, line 26; figure 5	12
A	US,A,4 706 117 (SCHOOLMAN) 10 November 1987 cited in the application see column 7, line 11 - line 32; figure 6 see column 6, line 16 - line 31; figures 5-8	16,17

3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/HU 96/00051

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